

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

| | | |
|----------------------------------|---|------------------------------|
| In the Application of |) | |
| Sean P. McCormack et al. |) | John C. Ball, Examiner |
| Serial No. 10/591,491 |) | Confirmation No. 1930 |
| Filed June 4, 2007 (371(c) date) |) | Art Unit 1795 |
| Int'l App. No. PCT/GB05/00802 |) | Atty Docket No. COU.P.US0004 |
| Int'l Filing Date: March 4, 2005 |) | |
| For: ELECTROCHEMICAL SENSORS |) | |

DECLARATION OF DR. GREGORY WILDGOOSE PURSUANT TO 37 CFR 1.132

I, Dr Gregory Wildgoose, do hereby declare that:

1. My residential address is 12 Linalls Drive, Costessey, Norwich, Norfolk, NR8 5AS, United Kingdom, and I am named as an inventor on US Patent Application Serial No. 10/591,491.
2. I currently hold a prestigious Royal Society University Research Fellowship at the University of East Anglia, Norwich, UK. Prior to October 2009, I held a Junior Research Fellowship at St John's College, Oxford University after graduating with a DPhil in Chemistry in 2006 and an MChem in 2003, both from the University of Oxford. I have worked for several years studying the electrochemistry of chemically modified carbon and carbon nanotube electrodes, and have published circa 40 papers, several patents and one book chapter on this subject. I am a recognized international expert in the field of chemically modified carbon electrochemistry and frequently am invited to review materials submitted to more than 20 leading electrochemical and analytical chemical journals, as well as acting as a Consultant to several major industry leaders in this area.
3. As a named inventor, I have read the subject patent application and the Office Action issued by the United States Patent & Trademark Office dated July 8, 2010 in respect of US Patent Application Serial No. 10/591,491, wherein the Examiner indicates that claims 8, 9 and 11 to 18 are deemed to be obvious and, therefore, unpatentable in

view of the disclosure in Wrighton *et al.* (US 5,223,117).

4. I have reviewed the disclosure in US Patent No. 5,223,117 and make the following observations:

- US Patent No. 5,223,117 states that the redox reagents (on the working electrode) must be durably surface confinable (Column 4, lines 57-58). US Patent No. 5,223,117 also states that two examples of such redox reagents include:
 - (a) spontaneously self-assembling molecules (Column 4, lines 59-68), which are indicated to be preferred (Column 4, lines 65-68); and
 - (b) electrodeposited redox agents (Column 5, line 1).
- US Patent No. 5,223,117 further states that, in a preferred embodiment, the redox reagents are applied to "electrically conductive microelectrodes having good stability and the ability to be functionalized, such as platinum, gold, silver, palladium, and combinations thereof" (Column 5, lines 19-23).
- US Patent No. 5,223,117 further states that "[P]latinum and gold are optimal materials" (Column 5, line 35).
- Gold microelectrodes are used in the Examples of US Patent No. 5,223,117 (Column 6, line 48 to Column 12).
- A particular focus is on the use of the self-assembly of thiol reagents on the electrode surface (Column 6, lines 5-27; and Examples 1 to 4)
- The only mention of carbon as an electrode is in a list of possible materials recited in claim 6 (column 14, line 13).

5. In light of the above observations, the emphasis of US Patent No. 5,223,117 is on the use of working electrode substrates such as gold and platinum. In particular, I note that in Example 1 of US Patent No. 5,223,117, the self assembly of ferrocenyl thiol and quinone thiol onto gold microelectrodes is described. However, the surface chemistry of gold and platinum is very different to that of carbon, both in terms of quantitative and qualitative behaviour. Furthermore, the use of thiol reagents to modify carbon would not provide a spontaneously self-assembling monolayer as it would on a gold or platinum electrode. It is well known that self-assembled monolayers (SAMs) of thiols occur spontaneously when a platinum or gold metal is simply dipped in a solution of the thiol species, and there is a wealth of literature devoted to such SAMs and their formation. The energetics of the gold-S or platinum-S bond formation is sufficient to drive this process. This is because these metals have large (diffuse) d-orbitals and

some empty low-lying orbitals for bond formation with the donor sulphur ligand. Carbon has neither of these and usually has a full valence electron shell in materials such as graphitic carbon, so it is unable to spontaneously form a C-S bond, for which the C-S bond energy is insufficient to drive the process spontaneously. It is a well-known chemical fact that SAMs do not form on carbon through simple thermodynamic considerations.

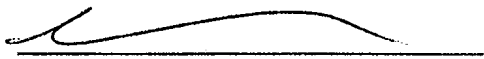
6. Given that one of ordinary skill in the art would have knowledge of the above and would appreciate that the surface chemistry of carbon is different to that of gold and platinum, one of ordinary skill in the art could not, on the basis of the teaching in US Patent No. 5,223,117, have predicted the use of carbon as an electrode with any reasonable expectation of success. I therefore do not believe that it would be obvious to one of ordinary skill in the art at the time the invention was made, and based on the teaching of US Patent No. 5,223,117, to contemplate a pH sensor comprising a carbon working electrode modified with a redox active species.

7. The use of a pH sensor comprising a working electrode comprising carbon modified with a chemically sensitive redox active material, as required by claim 8 of US Patent Application Serial No. 10/591,491, also provides additional advantages that are not taught by US Patent No. 5,223,117. Firstly, the thiol chemistry described in US Patent No. 5,223,117 will be especially sensitive to oxidation or reduction either by chemical species in the solution or by the direct effect of the applied electrode potential. These films may therefore show limited stability in many environments. In contrast, a carbon working electrode that is modified with a redox active species offers quantifiably improved stability and inertness under a wider range of conditions. Secondly, carbon electrodes are significantly less expensive to produce enabling them to be used for applications in which gold or platinum electrodes would be too impractical and expensive. Thirdly, the surface modification of carbon affords greater control which renders them particularly suitable for mass production.

I hereby declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

01/12/2010
Date


Dr Gregory G Wildgoose
12 Linalls Drive,
Costessey,
Norwich,
Norfolk, NR8 5AS, United Kingdom